INDUSTRIAL MINERALS IN SOUTHERN CALIFORNIA'S WALLBOARD JOINT CEMENT INDUSTRY

A POTENTIAL FOR MINERAL DEVELOPMENT IN ARIZONA

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Abstract

This report briefly describes southern California's wallboard joint cement industry, and in more detail, the specifications and quantities of industrial minerals consumed.

The Stouffer California wallboard joint cement manufacturing industry is believed to use a larger quantity of industrial minerals as extender pigments and functional fillers than any other southern California industry. Minerals used include limestone, talc, mica, kaolin clay, attapulgite clay, gypsum, and perlite. Southern California companies annually consume more than 640 million pounds (320,000 short tons) of minerals, with a value in excess of $15.5 million, for use in manufacturing joint cement. Since most of these minerals are not currently produced in Arizona, and Arizona deposits are within a reasonable shipping distance to southern California, a market for Arizona material exists.

Acknowledgements

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Development Potential in Arizona

An opportunity for development of Arizona mineral deposits exists. Few of these minerals are currently mined in Arizona, despite the likelihood that significant deposits occur in the state. Joint cement manufacturers in southern California are within a reasonable distance from Arizona deposits. In many cases their current sources are more distant. Arizona's joint cement manufacturers in Arizona and the Southwest use many of the same minerals.

Wallboard Joint Cement

The wallboard joint cement manufacturing industry in Southern California is believed to use the largest quantity of industrial minerals as functional fillers of any Southern California industry. For the purpose of this report, products such as wallboard texture coatings and ceiling texture spray coatings are included.

Wallboard joint cement is known by a number of common names including 'dry wall mud,' 'tape joint compound,' 'joint cement,' and 'mud.' It is the sealer and adhesive used to attach joint tape to the junctions between sheets of gypsum wallboard on walls and ceilings. Wallboard is also called gypsum board and Sheetrock®.

In addition to being used with joint tape to hide or conceal joints, it is also used to cover nail and screw heads and to cover the wallboard's paper surface to provide an equally absorbent and uniform surface prior to the application of a decorative coating such as paint.

Wallboard joint cement is produced in a number of different varieties for use in various applications. Types such as chemically setting, lightweight, topping, and all-purpose are all made for differing applications or environmental conditions of application. Wallboard joint cement is manufactured as both a wet ready to use product and as a dry powder that

must be mixed with water at the job site prior to application.

Wall and ceiling texture compounds are manufactured for application to wallboard surfaces after taping and sealing to provide a decorative texture for walls and ceilings. Wall texture coatings are nearly always subsequently painted, while ceiling texture coatings do not necessarily require painting.

Wallboard joint cement is a mixture of raw materials. It generally consists of a binder, water, chemical additives, and mineral fillers. The binder is either a liquid vinyl resin as a latex for wet, ready to use products or a starch or spray-dried vinyl resin for dry mix products. Chemical additives include ethylene glycol (to prevent freezing or control drying time), various dryers, and preservatives. The mineral fillers make up the major portion of the product.

Wall and ceiling texture coatings additionally contain hiding pigments such as titanium dioxide. Ceiling coatings usually contain coarsely ground expanded polystyrene particles. Ceiling coatings requiring acoustical properties may contain expanded vermiculite or popped perlite.

Ready to use wallboard joint cement is packaged in four gallon boxes weighing 50 pounds, one gallon pails, and pails weighing 62 pounds. Dry mix joint cement is packaged in 25-pound bags. Lightweight joint cement made in southern California is packaged in four-gallon boxes weighing 30 - 40 pounds.

Functional Fillers

Functional fillers for wallboard joint cement can, for the purpose of discussion, be divided into two groups; those which impart some useful property such as strength or sag resistance to the final mixture and those that fill space, add bulk, and extend the usefulness of the other constituents. Ground limestone is the most common bulk filler in joint cement, but many white, non water-soluble mineral fillers could be used in its place if they were available at a competitive price. Functional fillers used include mica, talc, kaolin clay, attapulgite clay, and popped perlite.

Southern California’s Joint Cement Manufacturing Industry

Southern California's joint cement manufacturing industry consists of seven plants producing over 18 million boxes (average weight per box: 50 pounds or the equivalent in pails and dry mix material) of joint cement and wall texture coating a year. In addition to the six companies listed under acknowledgements on page 1, Gold Bond Building Products operates a joint cement manufacturing plant in Long Beach, California. These plants manufacture nearly all of the joint cement consumed in the state, supply about 20 percent of the joint cement consumed in Arizona, and export material to other states and foreign countries. Most of the plants produce joint cement and wall/ceiling texture coatings. Major gypsum wallboard manufacturers operate two of the plants. One company produces a complete line of do-it-yourself wall repair products including tile grouts and patching materials primarily distributed through retail establishments.

Wallboard joint cement is used in new and remodeling construction only. Thus the economic health of that industry directly affects the quantity of joint cement consumed. Further, it is used when gypsum wallboard is used as an interior wall or ceiling covering. Neither wood or vinyl paneling nor lathe and plaster require joint cement.

Industrial Minerals in Joint Cement

Southern California joint cement manufacturers consume at least six different industrial minerals as functional fillers. They are listed in Table 1 along with typical annual consumption and prices. Typical price ranges are given to help estimate the size of the market. The lowest prices are often those paid by warehouses and the largest bulk users, while the highest prices are often in quantities of single pallet loads and materials obtained through distributors' warehouses. Material may be supplied in bulk rail cars, bulk trucks, ‘super sacks’ (bulk bags which hold from 1000 to 3000 pounds), or in 50-pound paper bags. The larger consumers often negotiate prices and delivery contracts directly with the mining-processing-supplier company at terms lower than published prices.

The industrial minerals used in joint cement manufactured in the state are described in the remainder of this chapter. All are very finely ground and must conform to detailed specifications. Some are interchangeable in certain uses.

Those interested in developing new sources of these minerals should be fully aware of the idiosyncrasies of the industrial minerals industry. Suppliers of minerals to the industry are expected to provide considerable technical data and support to potential consumers.

Table 1. - Industrial Minerals Used by Southern California's Wallboard Joint Cement Manufactures - Typical total annual consumption

Commodity	Quantity	Price Paid by Consumers	
	(tons)	Minimum paid	Maximum paid
Limestone	264,000	$33	$50
Mica	9,646	248	280
Talc	1,966	82	139
Kaolin	5,702	119	200
Attapulgite clay	2,869	233	
Perlite	3,590		
Bentonite Clay	2,135		
Sepiolite Clay	3,708		
Gypsum	2,400		
Silica *	25,000		
Diatomaceous Earth	Could be used in place of perlite fines		
Pyrophyllite	Could be used in place of some mica		
Wollastonite	Could be used in place of some mica		
Feldspar	Could be used in place of some to all limestone if it were available at a competitive price		

*Silica is used primarily in tile grout products but is included here to protect individual company proprietary data.

Calcium Carbonate

The most used filler in joint cement is calcium carbonate, primarily used as fine ground white limestone or marble. It is ground much finer than 325 mesh with the mean particle size being in the range of 10 to 15 microns. Calcium carbonate supplies volume solids or bulk at a low cost. At about $0.017 per pound (or 42 to 51 cents per 50 pound box), it is the cheapest ingredient in joint cement.

Calcium carbonate's tendency to 'frost' or 'chalk' when repeatedly exposed to moisture does not present a problem in joint cement. Joint cement is very seldom used in exterior applications and is always protected by painting.

The three most important specifications for ground calcium carbonate to be used in joint cement are whiteness, chemical stability, and particle size. Whiteness is important because the finished product must be white to avoid showing through paint coating applied over the joint cement, especially since most interior walls in residential construction are painted white or very light colors. Whiteness should be above 90. Fine and consistent particle size is important to manufacturing a joint cement that applies evenly. The necessity for chemical stability is somewhat nebulous. Limestone or marble that can be ground for joint cement use must be free of water soluble or water absorbable foreign

minerals that could cause tape adhesion problems or the appearance of blemishes in the wall coating. Common clays are typical impurities that should be avoided. However, the limestone or marble need not be pure CaCO3. Dolomitic limestone or marble can be used if white. Many white silicate minerals such as a feldspar or pyrophyllite could also be used, but must compete on a price basis with ground limestone.

All of the ground limestone used by Southern California joint cement manufacturers is produced at Lucerne Valley in southern California. The cost of shipping ground limestone from Lucerne Valley to the various southern California area manufacturers ranges from $8.00 to $11.00 per ton in bulk trucks.

Calcium carbonate used in joint cement is one of two average particle sizes: 10 microns 15 microns (U.S. sieve mesh 325 is approximately 44 microns).

A typical specification for fine ground calcium carbonate used in the manufacture of wallboard joint cement is shown below:

Typical Chemical Analysis (Calcium Carbonate)

$CaCO_3$	Minimum 97-98%
$MgCO_3$	1 %
Acid insoluble	2%

Typical Particle Size Distribution

Retention on 325 mesh screen	<1 %
Mean particle size	10 microns

Percentage by weight finer than:

Microns	%
44	99 min
20	85
15	70
10	50
5	25
2	13

Typical Physical Characteristics

Dry brightness	92 %
Gallons per pound	0.0445
Pounds per gallon	22.5
Specific gravity	2.71
Moisture	less than 0.20%
ph Factor	9.5
Oil absorption	11

Kaolin

Kaolin, also known as kaolin clay or kaolinite, and sometimes referred to as china clay or aluminum silicate, is a functional filler that is white, has some hiding power, provides some strength, and ties up water to control drying. Its hiding power is a result of the delaminated clay particles piling up and overlapping. As a filler it is chemically inert. It also improves spreadability.

All of the ground kaolin used by southern California joint cement manufacturers is shipped from northern California. The cost of shipping ground kaolin from northern California to southern California area manufacturers ranges from $15.00 to $25.00 per ton in truckload quantities.

A typical specification for fine ground kaolin is shown below:

Typical Chemical Analysis

Al_20_3	38.8%
SiO_2	45.2%
Na_2O	0.05-0.3%
TiO_2	0.6-1.7%
CaO	0.02 %
Fe_20_3	0.3-0.9%
MgO	0.03%
K_20	0.05-0.2%
Loss on ignition	13.6-14.2%

Typical Particle Size Distribution (Kaolin)

Retention on 325 mesh screen	0.15%
Mean particle size	4.8 microns
(Equivalent spherical diameter)	

Percentage by weight finer than:

Microns	%
20	99+
10	85
5	50
2	21

Typical Physical Characteristics

Physical	Highly pulverized powder
Dry brightness	79-82%
Specific gravity	2.58
Moisture	less than 1.0%
ph Factor	3.5-5.0
Oil absorption	30-35
Refractive index	1.56
Bulk density (loose)	24 lbs/cu ft
Bulk density (tamped)	45 lbs/cu ft

Attapulgite Clay

Attapulgite clay is a gelling clay used as a thickener and/or thixotropic agent. It provides sag control, aids in spreadability of the final product, and the holding of ingredients in suspension.

Nearly all of the attapulgite clay used by Southern California joint cement manufacturers is imported from the Georgia - Florida area of the southeastern United States. The cost of shipping attapulgite clay from the southeast U.S. to Southern California area manufacturers is approximately $105.00 per ton in truckload quantities.

Mica

Ground mica is used in joint cement where its platy structure and high aspect ratio (area: thickness) provides a number of useful properties. It prevents packing of the other fillers, adds strength to the applied layer on the wallboard, and aids in shrink and cracking control. Mica for use in joint cement must be white to a very light tan when ground and free of dark particles of other minerals. Air ground or micromized muscovite is most commonly used, but dry ground sericite or muscovite has been occasionally used. Both muscovite and sericite have been mined in Southern California in the past for use in joint cement.

Most of the ground muscovite mica used by Southern California joint cement manufacturers is imported from North Carolina. The cost of shipping ground muscovite mica from North Carolina to Southern California area manufacturers is in the range of $95 to $115 per ton in truckload quantities.

A typical specification for fine ground muscovite mica is shown below:

Typical Chemical Analysis

Theoretical chemical formula $H_2KAl_3(SiO_4)_3$

Typical Physical Characteristics

Color	White and lustrous
Particle shape	Very thin and platy
Particle size distribution:	
+60 mesh	nil
-60 + 1 00 mesh	1.5 % max.
-100 +200 mesh.	10.0% min
-325 mesh	50.0% min.
Chemical activity	Essentially inert except toH2
Loss on ignition	4-5%
Specific gravity	2.8-3.0
Moisture	0.25%
Oil absorption g/mg	80.0
Refractive index	1.58
Bulk density (apparent loose)	14lbs/cu ft
Hardness (MOHS)	2.5
ph	5.75
Surface area m^2/g	6.64

Pyrophyllite

Ground pyrophyllite could be used in joint cement in the same manner as mica. It is not currently used by any of southern California's joint cement manufacturers.

Talc

Talc is less expensive than mica and can replace some of the mica in joint cement where it provides similar properties. Its platy grain structure helps keep the mixture in suspension and aids workability.

Most of the ground talc used by Southern California joint cement manufacturers is imported from Montana, while some is still supplied from central California. The cost of shipping ground talc to Southern California area manufacturers ranges from $20 to $65 per ton in truckload quantities depending on whether the source is central California or Montana.

A typical specification for fine ground talc is shown below:

Typical Chemical Analysis

$Si0_2$	61.5-63.1%
MgO	31.0-32.9%
Al_20_3	0.93-2.37%
CaO	0.19-3.90%
Fe_20_3	1.00-1.30%
K_20	0.01-0.13%
TiO_2	0.05-6.20%
Loss on ignition	5.50-6.20%

Typical Particle Size Distribution

Retention on 100 mesh screen	nil
Retention on 200 mesh screen	nil
Retention on 325 mesh screen	2.0%

Typical Physical Characteristics

Dry brightness	80-84
Specific gravity	2.70
Apparent density	28.7 lbs/cu ft
Tapped density	56.5 lbs/cu ft

Perlite

Perlite is used in a ground, then expanded form, as a lightweight filler. Bag house fines from perlite expanding (also called popping) plants are also used. Perlite used in wallboard joint cement must be very white when expanded. It is used in place of some of the calcium carbonate.

Gypsum

Gypsum is used by some manufacturers in the form of plaster of Paris in rapid setting joint cement.

Diatomaceous Earth (diatomite)

Diatomaceous earth or diatomite is a filler primarily used in joint cement for its low effective density in light weight products. Because of the physical structure of the individual particles making up diatomaceous earth, they lay in a random, three-dimensional pattern that stiffens, reinforces and improves the durability of the final product. The variety of shapes also provides low density. The effective density of diatomaceous earth fillers is among the lowest of any mineral fillers at 1.98 to 2.33 grams per cubic centimeter. Diatomaceous earth occupies up to 30 percent more volume per pound than most other filler minerals.

Diatomaceous earth is not currently used by any of the southern California wallboard joint cement manufacturers.

Feldspar

White feldspar, if locally available, could replace limestone as the primary filler in wallboard joint cement. Reduced transportation costs would have to compensate for increased grinding costs. Southern California’s joint cement manufacturers do not currently use it.

Wollastonite

Wollastonite could be used in place of some mica and limestone in wallboard joint cement where the acicular shape of the ground wollastonite particles would provide many of the same properties provided by ground mica. It is not currently used by any of Southern California's joint cement manufacturers.

Conclusions

Southern California's wallboard joint cement industry is believed to use the largest quantity of industrial minerals as fillers of any industry in southern California. Many of these are currently imported into southern California, often from sources much further away than Arizona. Occurrences of most of these minerals, in particular, limestone, mica, kaolin, perlite, pyrophyllite, and diatomaceous earth, are known in Arizona. The consumption of these minerals in joint cement may be sufficient to justify a specialized multi-mineral producer operating a number of mines, each producing a specific mineral, but utilizing a common grinding/processing plant. Additionally, most of the same minerals are used in Arizona's joint cement plants. All have nearly the same specifications as those used in Arizona's and southern California's paint industry, although the quantities used in paint are much smaller. Thus a multi-mineral producer could produce for more than one Arizona and southern California industry. Further, southern California is a large market for industrial minerals in the manufacture of other products. It is expected that investigation of other industries in Arizona and southern California will yield consumption data that will produce totals of sufficient quantities to justify development of new mines in Arizona.